Rearing and Release of Coccinellids for Potential Control of Pear Psylla

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ABSTRACT

The lady beetle species--*Leis conformis* (Boisduval), *L. axyridis* (Pallas), *Coccinella septempunctata* L., *C. tranversoguttata* (Falderman), *Calvia quatuordecimguttata* (L.), *Menochilus quadriplagiatus* (Schönkerr), *Synharmonia conglobata* (L.), *Propylaea quatuordecimpunctata* (L.), and *Adalia bipunctata* (L.)--were reared on greenbugs, *Schizaphis graminum* (Rodani), produced on wheat seedlings grown in vermiculite. *L. conformis*, *L. axyridis*, and *L. dimidiata* (F.) were also reared on pea aphids, *Acyrthosiphon pisum* (Harris), and green peach aphids, *Myzus persicae* (Sulzer). Approximately 145,000 exotic (foreign) lady beetles (five species) were reared on greenbugs and pea aphids and released in deciduous fruit orchards in central Washington without apparent establishment. Results of overwintering studies indicated that *C. septempunctata* and *L. axyridis* may survive mild winters in central Washington.

KEYWORDS: Coccinellid rearing, pear psylla, *Leis conformis*, *Leis axyridis*, *Leis dimidiata*, *Coccinella 7-punctata*, *Coccinella tranversoguttata*, *Calvia 14-guttata*, *Menochilus quadriplagiatus*, *Synharmonia conglobata*, *Propylaea 14-punctata*, *Adalia bipunctata*.

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CONTENTS

REARING AND RELEASE OF COCCINELLIDS FOR POTENTIAL CONTROL OF PEAR PSYLLA[1]

By R. E. Fye[2]

INTRODUCTION

Hodek (*4*)[3] noted that the introduction of a new predator into a geographic area serves to either supply a predator for prey that has previously escaped predation or introduces an additional predacious species foreign to the native prey. We report here the results on the development of rearing methods to increase numbers of exotic (foreign) coccinellids for release against the pear psylla, *Psylla pyricola* Foerster, the major insect attacking pears in the Pacific Northwest. Eight species of exotic lady beetles, including *Leis conformis* Boisduval, *L. axyridis* (Pallas), *L. dimidiata* (F.), *Coccinella septempunctata* L., *Calvia quatuordecimguttata* (L.), *Menochilus quadriplagiatus* (Schönkerr), *Synharmonia conglobata* (L.), and *Propylaea quatuordecimpunctata* (L.), have been reared on greenbugs, *Schizaphis graminum* (Rodani), or pea aphid, *Acyrthosiphon pisum* (Harris). Major releases of *Leis* spp., *C. septempunctata*, and *M. quadriplagiatus* have been made in attempts to supplement pear psylla predation by the native *Anthocoris* spp. and *Deraeocoris* spp. The native predators are active in early to midsummer but do not have a major impact on populations of the pear psylla during the spring and fall. The coccinellids could be active during these periods.

METHODS AND MATERIALS

Several successful methods of producing aphid prey for the coccinellids were developed. Two methods were used to produce pea aphids, *Acyrthosiphon pisum*. In the first method, 2.5 cm of soaked vermiculite was layered in the bottom of a 3.8-L ice cream carton lined with a plastic bag. Pea seed soaked overnight was scattered over the surface of the vermiculite and then covered with about 10 mm of moistened vermiculite. When the sprouts of the pea seedlings emerged from the vermiculite, 8 to 10 sprouts heavily infested with pea aphids were placed on the vermiculite adjacent to the new sprouts. The cartons were then covered with nylon organdy mesh and held in a constant temperature room at 20° to 22°C and 40

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[3]Italic numbers in parentheses refer to Literature Cited, p. 9.

to 60 percent relative humidity. Within 6 to 8 days, the cartons contained adequate numbers of pea aphids with which to feed lady beetles or with which to reinfest new pea seedlings.

In the second method, peas were soaked overnight, placed in hardware cloth baskets lined with paper towels, and then covered with an additional layer of paper toweling. The trays were held in a sprouting chamber that consisted of a small metal cabinet with open shelves and a shower head in the top. The shower head was connected through a clock-controlled solenoid valve to a water source. At 2-h intervals, the peas were rinsed to remoisten the toweling around the sprouting peas. After 3 days in the chamber at about 25°C, the pea sprouts were ready for infestation.

To start a rearing container, we placed four squares of absorbent toweling in the bottom of a 237-ml waxed paper cup and moistened it. Eleven sprouts heavily infested with pea aphids were placed in the edge of the cup, and 11 sprouting peas were placed on the paper toweling. Within 2 days at 25°C, the aphids transferred to the pea shoots. At the end of 4 days, the cups were opened, the paper toweling was remoistened, and nine additional sprouted peas were added. By the end of 7 or 8 days, the aphid population had doubled, and the peas were ready for infestation with lady beetle larvae or recycling as infesting material for subsequent culturing.

A third method employed green peach aphids, *Myzus persicae* (Sulzer), reared on sugarbeets in the greenhouse. Mature sugarbeets dug from the field were trimmed and placed in vermiculite in 15-cm pots. At the end of 3 weeks in the greenhouse at 20° to 26°C, the new beet foliage was ready for infestation with the green peach aphids. By the end of three additional weeks, the sugarbeet foliage was well covered with green peach aphids. For winter use, beets harvested in late fall were stored at 5° to 7° and withdrawn at weekly intervals. We fed the aphids to the coccinellids by picking the leaves and placing them in the rearing cages.

In the fourth method, biotype C of the greenbug, *Schizaphis graminum*, (5) was reared on seedling wheat as described in the first method for the pea aphids. Wet vermiculite, placed in ice cream cartons lined with 30- by 45-cm plastic bags, was covered with a light seeding of wheat and then covered with a very thin layer of dry vermiculite. After 3 days at 21° to 26°C in the greenhouse, the wheat seedlings emerged, and five or six new cartons of sprouting wheat were infested with greenbugs from a previously infested carton. The cartons were then covered with nylon organdy and held at about 22°. At the end of four additional days, the cartons of aphids were ready for infestation with lady beetles or for recycling in the culture. About 2 min was required to produce one carton of greenbugs.

The wheat method (method 4) proved the most successful, provided voluminous quantities of aphids for lady beetle production, and was used for the 1978, 1979, and 1980 releases. The sugarbeet method is somewhat more cumbersome than the others because it requires storage of a large number of sugarbeets in the fall if production is to be continued throughout the winter. In comparison, both pea aphid methods are laborious, and the vermiculite molds heavily on the surface and interferes with plant growth. In addition, the methods require a developed judgment at many points, and untrained personnel cannot manage them well.

We reared the coccinellids by placing 30 newly hatched larvae on the pea aphids on pea shoots in vermiculite, five to eight larvae in the 237-ml cups with sprouting peas, and 30 to 40 larvae in a carton with aphids on wheat. Several days later, when the larvae had completed feeding on the aphids in the container, they were transferred to a new container containing fresh aphids. A second transfer was usually necessary before feeding was completed on the peas or wheat in vermiculite. Several changes of pea sprouts were necessary to provide adequate numbers of aphids for the developing lady beetle larvae. Transfers were also made when the aphid host plants showed weakness because our previous experience had indicated that the aphids from chlorotic plants were either unacceptable to, or provided inadequate nutrition for, the lady beetles. The completion of feeding in a container or the inadequacy of the prey was generally heralded by the lady beetle larvae rising to the top of the container and clinging to the nylon organdy cover, removed to a new container. Pupae were removed from the cartons and placed in ventilated plastic boxes until the adults emerged. Survival from larva to adulthood was about 75 percent.

With each species of lady beetle, about 30 emerging adults were placed in rearing containers with aphids. Within 24 to 48 h, the entire aphid culture had been devoured and the adults had risen to the top of the container in a manner similar to the larvae. The adults were then removed to a new container and the eggs were removed from the old container. The eggs were placed in plastic petri dishes to hatch, and the neonate larvae were recycled to the continuing culture or released.

Adult beetles reared during the winter were successfully maintained on aphid prey at 10°C and 12L:12D photoperiod for the remainder of the winter. After a preoviposition period of 7 to 10 days at 24° and 16L:8D photoperiod, the adults were released in unsprayed orchards in the spring.

In field tests, the larvae were released in pear orchards with dense populations of pear psylla, *Psylla pyricola*, or, if pear psylla populations were low, on adjacent crops or weeds harboring populations of aphids or other soft-bodied insects. We released most of the lady beetles one day after hatching on the rationale that if the species were to survive in the new environment the insects should be exposed immediately to the environmental rigors that eventually determine their effectiveness and establishment.

To determine if the introduced lady beetles would feed and proliferate on a large population of pear psylla, we caged a single pear tree. Twenty adult *Leis axyridis* and 20 *L. conformis* were introduced in June 1978 and 1979. In addition, 18 *L. axyridis* and 33 *L. conformis* larvae were placed in the cage in July 1978, and 15 mature larvae of each of the same two species were introduced in late June 1979. We examined the tree frequently for indications of establishment or reproduction.

The overwintering capabilities of *L. axyridis*, *L. conformis*, *Calvia quatuordecimguttata*, *Coccinella septempunctata*, and *Menochilus quadriplagiatus* were tested during the winters of 1979-80 and 1980-81. Two replicates of 20 adults of each species were placed in cages in a screened insectary in a pear orchard in late May. The adults and their progeny were maintained in the cages throughout the summer and fall of 1979. Feeding of the greenbugs on wheat was terminated when snow covered normal food sources in the orchard. A container of crumpled

paper served as a potential hibernation site for the beetles. During the springs of 1980 and 1981, we examined the cages daily to determine if any of the coccinellids had survived.

RESULTS AND DISCUSSION

Seven species of exotic coccinellids that preliminary tests indicated would feed on pear psylla were successfully reared with the wheat-greenbug method. *Leis conformis*, *L. axyridis*, *Coccinella septempunctata*, *Menochilus quadriplagiatus*, *Calvia quatuordecimguttata*, *Synharmonia conglobata*, *Propylaea quatuordecimpunctata*, and two local species, *Coccinella tranversoguttata* Falderman and *Adalia bipunctata* (L.), were reared for experiment or release. Thus, the wheat-greenbug method provides large quantities of aphids as a satisfactory alternative for the commonly fed potato tuberworm, *Phthorimaea operculella* (Zeller), an unwanted pest heretofore undetected in Washington potato growing areas. Use of the potato tuberworm as prey for the coccinellids would necessitate rearing under quarantine conditions.

The numbers of exotic coccinellids released from 1977 through 1980 are presented in table 1. Although the larvae, some in later stages, were observed from time to time in the release orchards, only rarely were adults detected during the same season in weekly or biweekly beating tray examinations of the release trees. In August 1980, *M. quadriplagiatus* larvae were observed to mature on a large prey population of the green apple aphid, *Aphis pomi* DeGeer, in a young apple orchard adjacent to pears. Oviposition also occurred, but no survivors were detected, in the spring of 1981. In addition, we found no evidence (1) of mass feeding by the coccinellids on the pear psylla, (2) of maturation of the released larvae, or (3) of oviposition by the released adults on the caged tree. Thus, although a number of adults of these species were detected, their rarity or ephemerality indicated that none of the introduced species have been established in Washington orchards to date.

About 20 adult *Coccinella septempunctata* adults survived the winter of 1979-80 in the Yakima insectary. The temperatures were relatively mild, with 1,211 h at 0°C or below, 415 h at -5° or below, and 109 h at -10° or below. The winter of 1980-81 was milder, and 27 *C. septempunctata* and 38 *Leis axyridis* survived. The abnormally mild temperatures included only 600 h at 0° or below, 65 h at -5° or below, and 8 h at -10° or below. Additional tests to ascertain their survival potential under more severe temperature stress, that is, the 1978-79 winter with 1653, 743, and 361 h at temperatures of 0, -5, and -10° or below, respectively, will be necessary to determine the full extent of the species survival potential under central Washington conditions.

Angalet and Jacques (*1*), Angalet et al. (*2*), and Cartwright et al. (*3*) have reported successful establishment of *Coccinella septempunctata* in New York, New Jersey, Connecticut, Delaware, Georgia, and Oklahoma, suggesting a potential for establishment under various climatic conditions. The screened insectary tests indicate a winter survival potential under Washington conditions. *Leis conformis*, of Australian origin, and *L. axyridis*, of Japanese origin, failed to survive the relatively mild 1979-80 winter; however, the survival of the *L. axyridis* adults through the winter of 1980-81 suggests a slight potential for that species.

Table 1.--*Release of exotic coccinellids in Washington, 1977-80*

	No. of coccinellids released									
	Leis conformis[1]		*Leis axyridis*[2]		*Leis dimidiata*[1]		*Coccinella septempunctata*[2]		*Menochilus quadriplagiatus*[3]	
	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults
Yakima										
1977										
June					45					
July	1,440									
August	395	285			81	98				
Totals	1,835	285			126	98				
1978										
March	58	52								
May	127		267							
June			101							
July										
Totals	185	52	368							
1979										
April	2,041	694	656					1,834		
May	4,122	140	1,573	90			1,094	75		
June	5,737		177	43			1,286			
July	5,788						436		642	
August	1,634								1,478	
September	1,107								4,852	
October									1,845	
Totals	20,429	834	2,406	133			2,816	1,909	8,817	

See footnotes at end of table.

Table 1.--*Release of exotic coccinellids in Washington, 1977-80*--Continued

	No. of coccinellids released									
	Leis conformis[1]		*Leis axyridis*[2]		*Leis dimidiata*[1]		*Coccinella septempunctata*[2]		*Menochilus quadriplagiatus*[3]	
	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults
Yakima--Continued										
1980										
April	1,657	234		137					2,260	450
May	3,496	76	3,170	177					11,209	216
June	152	0	2,407	169					4,778	281
July	138		570	48					1,494	0
Totals	5,443	310	6,147	531					19,741	947
Wapato										
1980										
July	748		2,832	135					2,889	296
August	1,064		4,643	180					7,835	203
September	1,757		3,596	0					8,395	0
October	909		762						4,291	
Totals	4,478		11,833	315					23,400	599
Tieton										
1979										
May	132							964		

1980								
May				106				128
July			495				521	0
Totals			495	106			521	128

Gleed

1980								
June	55		1,275				1,367	
July	247		1,328	91			1,087	181
August	496		516				832	
Totals	799		3,119	91			3,286	181

Husum

1979								
April	362	80	76	80				
May	381		185			941		
June	1,185	50	126	60	298			
August	978						1,559	
Totals	2,906	130	387	140	298	941	1,559	
1980								
June			2,353				2,117	279
July	635		1,602	147			1,703	100
August			1,026	150			2,447	180
Totals	635		4,981	297			6,267	559

See footnotes at end of table.

Table 1.--*Release of exotic coccinellids in Washington, 1977-80*--Continued

	No. of coccinellids released									
	Leis conformis[1]		*Leis axyridis*[2]		*Leis dimidiata*[1]		*Coccinella septempunctata*[2]		*Menochilus quadriplagiatus*[3]	
	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults
					Wenatchee					
1980										
July	350	70	540	57					672	88
Overall totals.	37,192	1,681	30,276	1,670	126	98	3,114	3,814	64,263	2,502

[1]Cultures supplied by K. Hagen, University of California, Berkeley.
[2]Cultures supplied by George Angalet, USDA, Beneficial Insects Research Laboratory (BIRL), Newark, Del.
[3]Cultures supplied by Paul Schaeffer, USDA, BIRL, Newark.

Overall, the failure of *L. conformis*, *M. quadriplagiatus*, and *C. quatuordecim-guttata* and the slight success of *C. septempunctata* and *L. axyridis* to overwinter suggest these species have inadequate physiological-ecological attributes for potential establishment in central Washington.

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